Deliquescence of Perchlorate Salts on the Surface of Mars. R. A. Rosario[1, 2], H.N. Farris[2], A. Elsenousy[2], V.F. Chevrier[2], [1]Department of Physics and Astronomy Stony Brook University, 100 Nicolls Rd Stony Brook, NY 11790, rafael.rosario@stonybrook.edu [2]Arkansas Center for Space and Planetary Sciences, Old Field House University of Arkansas, Fayetteville, Arkansas 72701.

Introduction: In 2003, NASA's Mars Odyssey mapped out the water concentrations in the martian surface (fig. 1). The water is concentrated in the Polar Regions prompting the NASA's Phoenix lander mission to land in the northern polar regions of Mars. There, Phoenix has discovered perchlorates in the soil surface in amounts of 0.4-0.6 wt% using the Wet Chemistry Lab (WCL) equipped with it. These perchlorates have the property to deliquesce, to absorb the water vapor and form an aqueous solution [1].

The interest with these perchlorates is it has a low temperature where the solution is stable in the liquid phase, a low eutectic temperature [2]. The WCL has found perchlorates of magnesium, sodium, hydrogen, calcium, and ammonium from three samples that the Robot Arm (RA) Phoenix was equipped with had scooped up [1]. With the perchlorates having low eutectic temperature, under suitable temperature and relative humidity (RH) deliquescence can occur forming a liquid brine with the perchlorates which may remain stable for limited periods of time.

Experimental Setup: The experiment was to observe deliquescence through visual (microscope and webcam) and reflectance spectra (Fourier Transform Infrared Spectrometer) under ambient pressure and a temperature of 0° C using a chiller. A sample of 200g with a mix ratio of 10 wt.% perchlorate to 90 wt.%

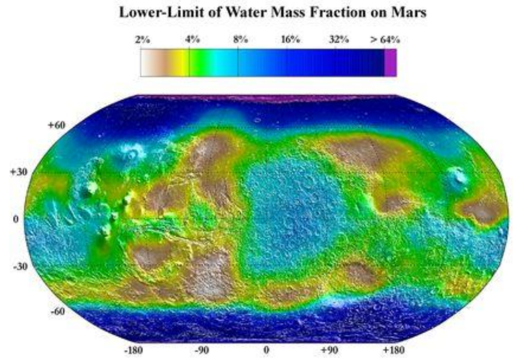

Figure 1: Map of water on Mars made by Mars Odyssey in 2003. The regions with concentrations greater than 30% are in latitudes greater than about 60° north or south and concentrations can exceed 60% in the northern polar region. Credit: NASA/JPL/Los Alamos National Laboratory

temperature of 0° C using a chiller. A sample of 200g with a mix ratio of 10 wt.% perchlorate to 90 wt.% basalt would be positioned inside a sealable chamber that could simulate martian conditions and this chamber has been dubbed Ares Chamber. To control the RH, a NaBr humidity buffer will be placed inside of the chamber which would set the RH to ~56% when the temperature is 0° C [3]. Ares Chamber has a fiber optic with the capability of going up to 5 µm. It has a hygrometer and a thermocouple to confirm conditions have been met and a LED light source. Spectra were taken throughout the experiment run allowing to see the progression of deliquescence, with a microscope and webcam to verify deliquescence visually.

The perchlorate chosen was $Mg(ClO_4)_2$ due to having the lowest eutectic temperature therefore being able to having a greater chance of forming a stable liquid [2]. A sample of $Mg(ClO_4)_2$ mixed with basalt is prepared by baking for ~12 hours to remove any preexisting moisture within the sample and placed within a desiccator to prevent moisture from being replaced during transportation from the oven to Ares Chamber. While the sample is baking the NaBr humidity buffer is also prepared and properly stored until it is time to place the humidity buffer and sample inside of Ares Chamber. The chiller is set to 0° C the day before the experiment ran to give the chamber sufficient time to go down to the desired temperature. After the sample and buffer are placed inside of Ares

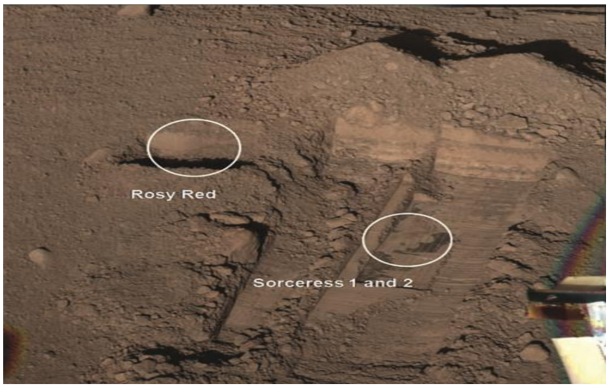

Figure 2: The site of where the three samples the WCL had analyzed named Rosy Red, Sorceress 1, and Sorceress 2. The image is a mosaic of two images taken on sol 31, altered to appear in color. [1]

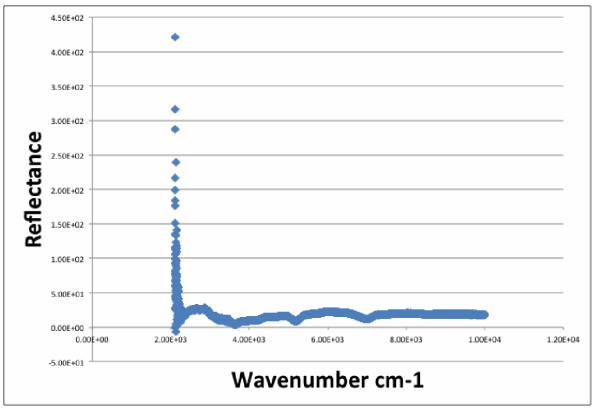

Figure 3: Initial spectra of the sample. Water bands can be seen at 3000, 5000, and 7000 cm^{-1}.

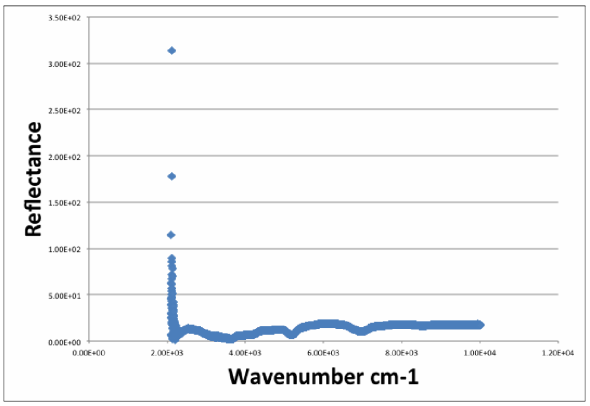

Figure 4: Spectra of sample after 14 hours the water bands are slightly deeper than initially seen.

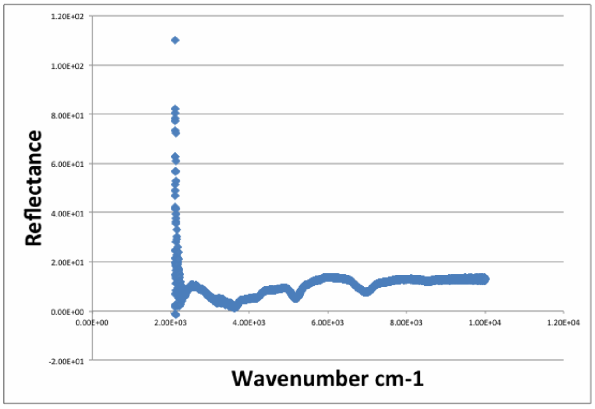

Figure 5: Spectra of sample after 21 hours the waterbands have deepened showing that the sample is absorbing water vapor however at a debilitate rate.

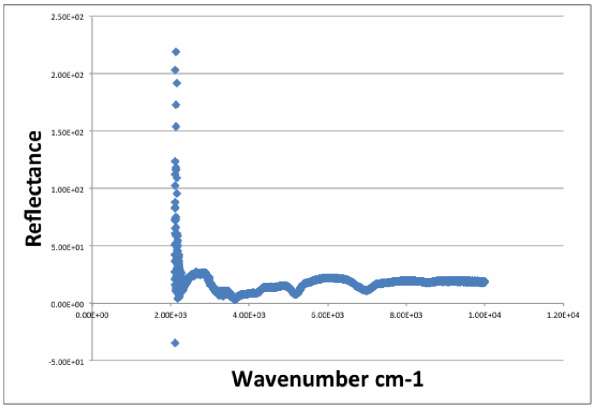

Figure 6: Spectra of sample after 41 and hours the water bands does not seem to have deepened much however reflectance did increase.

Chamber, the lid is lowered and sealed. Once everything is set in place, initial spectral is taken. The fiber optic is connected to a FTIR spectrometer with an Iridium Antimonide (InSB) detector that is cooled down with liquid nitrogen.

Results and Discussion: The experiment ran for ~41 hours and from low relative humidity the sample never deliquesced, however, the sample did partially deliquesced as verified by the spectra in figs. 3-6. Ares Chamber had a temperature gradient which caused the buffer to equilibrated poorly providing a RH of ~15%. Setting the chiller to -15% in an attempt to increase the RH caused the RH to decrease instead to ~10%.

Conclusion and future work: The Ares Chamber has a non-uniform temperature gradient which caused the NaBr humidity buffer to equilibrate with the atmosphere incorrectly, producing a relative humidity lower than expected. This low humidity hindered deliquescence; therefore improvements to the Ares Chamber are needed before further experimentation may take place. These improvements being increasing the number of hygrometers and thermocouples, decreasing the temperature gradient as well as proofing the chamber for leaks so as to obtain a martian atmosphere of 6 mbar.

References and Acknowledgements: [1] Hecht, M. H. et al. (2009) Science, 325, 64-67 [2] Chevrier, et al. (2009) GRL, 36, L10202. [3] Wexler, A. Constant Humidity Solutions [Website] Retrieved from http://www.hbcpnetbase.com

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